Department of Chemistry
Curriculum and Syllabi for M. Sc in Applied Chemistry
With effect from 2019 entry batch

Programme outcome statements:

1. **Students should be able to acquire comprehensive knowledge about various broad areas of fundamental as well as applied chemistry**
2. **Graduates of the programme will be able to develop the skill and confidence needed to undertake research problems in any frontier areas of the research in fundamental and applied chemistry**
3. **Graduates should be able to develop a sense of responsibility towards various social and environmental issues.**
4. **Students should develop ability to work in a team to work successfully in relevant industries in the country as well as in abroad maintaining high ethical** values.

Semester I

Subject Code	Subject	L	T	P	Credit
CH 5101	Organic chemistry	4	0	0	4
CH 5102	Inorganic chemistry	4	0	0	4
CH 5103	Physical chemistry	4	0	0	4
CH 5104	Inorganic chemistry Laboratory	0	0	6	4
CH 5105	Organic chemistry Laboratory	0	0	6	4
	Total	12	0	12	20

Semester II

Subject Code	Subject	L	T	P	Credit
CH 5106	Synthetic Methods in Organic Chemistry	4	0	0	4
CH 5107	Environmental Chemistry and Engineering	4	0	0	4
CH 5108	Physical Methods in Analytical Chemistry	4	0	0	4
CH 5109	Physical Chemistry Laboratory	0	0	6	4
	Total	12	0	12	16

Semester III

Subject Code	Subject	L	T	P	Credit
CH 6101	Chemical Engineering principles	4	0	0	4
CH 6102	Polymer Chemistry	4	0	0	4
CH 6103	Green Chemistry and Technology	4	0	0	4
CH 6104	Environmental Chemistry Laboratory	0	0	6	4
CH 6105	Seminar				1
	Total	12	0	0	17

Semester IV

Subject Code	Subject	L	T	P	Credit
CH 6106	Synthesis and Reaction of Inorganic and Organometallic compounds	4	0	0	4
CH 6199	Project work	----	-----	-----	10
CH 613X	Elective	3	0	0	3
	Total	8	0	0	17

Electives

Sl No.	Name of the Course	Course No.
1	Petroleum Science and Technology	CH – 6131
2	Catalyst and Surface Science	CH – 6132
3	Fuel Technology	CH – 6133
4	Energy and Environment	CH – 6134
5	Natural Products and Medicinal Chemistry	CH - 6135

Detailed Syllabi

CH 5101	Organic Chemistry	L	T	P	C
M Sc in Applied Chemistry, First semester (Core)		4	0	0	4
Prerequisite(s): No Prerequisites					

Reaction Mechanism:

A review of reaction mechanism including methods of determination, generation, structure, stability and properties of carbocation, carboanion, free radical, carbene, nitrene.

Nucleophilic substitution: The S_N2, S_N1 mixed S_N1 and S_N2 and SET mechanism. Electrophilic substitution: Bimolecular mechanism SE2 and SE1.

Thermodynamic and Kinetics:

Acids and bases, labeling and kinetics isotope effects, Hammett equation, sigma-rho relationship, non-classical carbonium ion, neighboring group participation, kinetics and thermodynamics control.

Stereochemistry:

Elements of symmetry, asymmetry and dissymmetry, Chiral carbon atom, cause of optical activity, enantiomers, diastreomers, Optical isomerism in tartaric acid, allene, biophenyls, Racemization, resolution, methods of resolution (Biochemical and chemical methods), Conformational analysis of simple cyclic and acyclic system. Walden inversion, Asymmetric synthesis, Stereoselective and streospecific synthesis, designation of cis-trans and E-Z notation

Topocity and Prostereoisomerism:

Topocity of ligands and faces and their nomenclature, streogenicity, chirogenicity, pseudoasymmetry, streogenic centre.

Heterocyclic compounds:

Methods of synthesis, aromatic character and reactivity of five-member and six member heterocyclic compounds

Text Books/References:

1. Advance Organic Chemistry by J. March, John Wiley and Sons, 1992
2. Organic Chemistry by S.H.Pine, Mc Graw Hill, 1987
3. A guide book of Mechanism in organic Chemistry, Peter Sykes Longmann
4. Principles in Organic Synthesis, R.O.C Norman and J.M.Coxon
5. Stereochemistry of Carbon Compounds by E.J.Eliel, McGraw Hill
6. Stereochemistry of Organic Compounds by D. Nasipuri, Wiley, 1994
7. Organic Chemistry by I L Finan 5th edition
8. Organic Chemistry by Marrison & boyd, 5th edition.

CO Statements:

1. CO1: To provide students with a fundamental understanding of the relationship between molecular structure and reaction mechanism in chemical processes
2. CO2: To provide students with an understanding of linear free energy relationship and the use of Hammet plots in predicting reaction rates/ investigation of reaction mechanisms.
3. CO3: To provide students with fundamental understanding of stereochemical features of organic molecules.
4. CO4: To provide students with fundamental understanding of heterocyclic molecules with N, S, X with variation of their properties and their uses

CH 5102	Inorganic Chemistry	L	T	P	C
M Sc in Applied Chemistry, First semester (Core)		4	0	0	4
Prerequisite(s): No Prerequisites					

Non-transition metal chemistry:

Synthesis, properties, structure and bonding of: Nitrogen, phosphorous, sulphur, pseudohalogen, interhalogen and xenon compounds; boranes, carboranes, metalloboranes, borazines, phosphazenes, sulphur-nitrogen compounds.

Transition metal chemistry:

Nomenclature, isomerism, chelate-effect, bonding in coordination compounds: valence bond theory, crystal field theory, d-orbital splitting in octahedral, tetrahedral, square planar complexes, Jahn-Teller effect, spectrochemical series, nephalauxetic series.

Electronic and magnetic properties of metal complexes:

Magnetism: types, determination of magnetic susceptibility, spin-only formula, spin-orbital coupling, quenching of orbital angular momentum, spin crossover. Electronic spectra: spectroscopic terms, d-d transitions, charge-transfer transition, selection rule and intensities, Orgel diagram, Tanabe-Sugano diagram.

Acid-Base Chemistry:

Different Concepts in Acid-base: the solvent-system definition, Bronsted-Lowry definition, Lewis Concept, Lux-flood theory, Usanovich definition. Strengths of Bronsted Acid and based, Strengths of Lewis acid and bases, Levelling effect of water, hard and soft acids and bases, super acids.

Oxidation Reduction Chemistry:

Basic concept, Electrochemical cell, Redox reactions and EMF, standard electrode potential and formal potential, factors affecting EMF of half-cells: effect of concentration, pH, complexation and precipitation. Redox stability in water, Redox titration

Bio-inorganic Chemistry:

Classification of biomolecules, metalloenzymes, sodium/potassium pumps and selectivity of the process, dioxygen binding, transport and utilization, hemoglobin and myoglobin functions, biological enzymes.

Text books/References:

1. Inorganic Chemistry: Principles of Structure and Reactivity by J. E. Huheey, E. A. Keiter and R. L. Keiter, 4th Ed. Harper Collins 1993.
2. General and Inorganic Chemistry Part I by R. P. Sarkar, 3rd Ed., NCBA, 2018.
3. Fundamental Concepts of Inorganic Chemistry, Volume III by Asim K. das, 2nd Ed., 2011.
4. Advanced Inorganic Chemistry by F. A. Cotton, G. W. Wilkinson, C. A. Murillo and M. Bochamann, JohnWiley & Sons, 6th Ed., 2003.
5. Inorganic Chemistry by D. F. Shriver and P. W. Atkins, 4th Ed., Oxford.
6. Concepts and Models of Inorganic Chemistry by B. E. Douglas, D. H. McDaniel, J. J. Alexander, John Wiley, 1993, 3rd Ed.
7. Inorganic electronic spectroscopy by A.B.P. Lever, Elsevier, 2nd Edition.
8. Introduction to magnetochemistry by A. Earnshaw, Academic Press.

CO statements:

1. CO1: Understand the synthetic and structural aspects of various compounds of main group elements such as boron, nitrogen, phosphorus, sulfur and halogen.

2. CO2: Interpret clearly the different bonding theories that govern the transition metal compounds in octahedral, tetrahedral and square planer geometries

3. CO3: Explain the various aspects of magnetic and spectral features of transition metal complexes

4. CO4: Demonstrate the significance of different definitions of acids and bases and their relevance in understanding the reactivity of inorganic compounds

5. CO5: Express the importance and significance redox chemistry involving metal and non-metal compounds

6. CO6: Understand the role of metal based biomolecules viz., metalloproteins in regulating various biological processes in man and animal.

CH 5103	**Physical Chemistry**	**L**	**T**	**P**	**C**
M Sc in Applied Chemistry, First semester (Core)		4	0	0	4
Prerequisite(s): No Prerequisites					

Chemical Dynamics and Electrochemistry:

Determination of the order of reaction, rate laws, kinetics of complex reactions: parallel, consecutive and reversible reactions, steady state concept: Arrhenius equation, energy of activation and its experimental determination, simple collision theory-mechanism of bimolecular reaction, chain reactions, activated complex theory of reaction rate, ionic reactions: salt effect, photochemical reactions, Energy Kinetics. Michaelis-Menten mechanism, acid-base catalysis, Types of Catalysis, studies of Fast reactions by various methods. Electro Chemical cells Nernst equation and applications of Dabye-Huckal Theory. Electrolytic Conductivity and Dabye-Huckal treatment, over potential, corrosion.

Surface Chemistry:

adsorption: chemisorption and phyiosorption, application of adsorption of gases on solids, freundlich adsorption isotherm, Langmuir adsorption isotherm, BET theory of multilayer-adsorption, adsorption chromatography, electrical phenomena at interfaces including electrokinetics, Colloids and its applications,

micelles, reverse micelles, solubilization, application of photoelectron spectroscopy, esca and auger spectroscopy to the study of surfaces

Chemical Thermodynamics:

Brief review of laws of thermodynamic and thermodynamics functions, free energy and entropy changes in chemical processes, gibbs-helmholtz equation, free energy and entropy of mixing, partial molar properties, chemical potential, gibbs-duhem equation, chemical equilibrium, temperature dependence of equilibrium constant, phase diagram of one and two component systems, phase rule, thermodynamic description of phase transitions, clapeyron-claussius equation.

Photochemistry:

Principles of Photochemistry, Laws of photochemistry; Rates of intermolecular processes and intermolecular energy transfer. Photochemical reactions and their quantum yields. The ozone layer in the stratospheres, radiation chemistry, Application of photochemistry.

The Properties of solutions:

Liquid mixtures, colligative properties, The activities of regular solution. Partial molar quantities, The thermodynamics of activities; Osmosis; Osmotic pressure; molecular weight determination; abnormal behavior of solutions.

The Chemical Equilibrium:

The law of mass action; Equilibrium constants; the reaction isotherm; The reaction isochore; Le Chatelier's principle; Equilibrium constants from partition functions.

Text Books/References

1. Chemical Kinetics by Keith Laidler Hopper and Row, 2000
2. Chemical Kinetics, The study of reaction rates in solution by Kennea A Connors, VCH 1999
3. Physical Chemistry by Peter Alkins- Jalio de Paula- 9th Edition.
4. Physical Chemistry by Silbay Alberty- 9th Edition
5. Physical chemistry by David W. Bath

CO statements:

1. CO1: Explain in details the theories of reaction rate and their utilization and principle of electrochemistry.
2. CO2: Learn in details the theories of surface chemistry and their applications.
3. CO3: Relate thermodynamic properties of the system and the chemical composition.
4. CO4: Comprehend the principle and applications of photochemistry
5. CO5: Explain the principle and various properties of dilute solutions.
6. CO6: Learn the principle and applications of chemical equilibrium.

CH 5104	Inorganic Chemistry Laboratory	L	T	P	C
M Sc in Applied Chemistry, First semester (Core)		0	0	6	4
Prerequisite(s): No Prerequisites					

List of Experiments:

1. Determination of Copper(II) in a given solution
2. Estimation of Zinc(II) in a given solution
3. Determination of Iron(II) in a given solution
4. Determination of Iron(III) in a given solution
5. Estimation of Iron(II) and Iron(III) in a given mixture
6. Estimation of Calcium(II) and magnesium(II) in a given mixture
7. Preparation of tris(acetylacetonato)iron(III)
8. Preparation of tetrabutylammonium octamolybdate(VI)
9. Preparation of pentaamminechlorocobalt(III) chloride
10. Gravimetric estimation of Nickel
11. Gravimetric estimation of Barium

Text books/References:

1. Vogel's Textbook of Quantitative Chemical Analysis
2. Advanced practical Chemistry by S. C. Das, 5th Edition.
3. Practical Inorganic Chemistry by S. Gulati, JL Sharma, S. Manocha, CBS Publication.

CO Statements

CO 1: Able to demonstrate the complete skill for performing experiments in regards to both preparation metal complexes as well as estimation of metals from the complex as well as mixture of ions thorugh volumetric and gravimetric analytical procedure.

CH 5105	Organic Chemistry Laboratory	L	T	P	C
M Sc in Applied Chemistry, First semester (Core)		0	0	6	4
Prerequisite(s): No Prerequisites					

List of experiments

1. Qualitative analysis of binary mixture:

(a) Separation of the mixture and Solubility test (water, 5% NaOH, 5% $NaHCO_3$, dil. HCl & conc. HCl).

(b) Detection of Elements.

(c) Inference of sample by determination of melting point.

(d) Preparation of derivatives.

(e) Confirmation of the derivatives by determining its melting point.

2. Chromatography:

(a) Thin layer Chromatography.

(i). Separation of mixture of methyl orange and methyl blue by TLC and calculation of Rf value.

(ii) Separation of mixture of 2,4-dinitrophenylhydrazones of acetaldehyde, benzaldehyde, and vanilline (chloroform) by TLC in the benzene: petroleum ether (3:1) mixture. Determination of R_f values.

(iii) Separation of mixture of aminoacids.

(b) Column Chromatography

(i) Separation of a mixture of O- and P-nitro anilines by using a column packed with alumina in benzene.
(ii) Separation of syn and anti azo benzene by using a column packed with alumina in petroleum ether and methanol.

3. Organic Preparations (more than one steps)

(a) Preparation of Methyl orange from aniline.

(b) Preparation of benzylated disulfide from o-Chloronitrobenzene by conventional as well as microwave technique.

(c) Preparation of p-Aminoazobenzene from aniline.

(d) Preparation of Acetanilide from Acetophenone.

(e) Preparation of N-phenyl-2, 4-dinitroaniline from chlorobenzene.

Text Book/References:
1. Dougles A. Skoog, Principles of Instrumental Analysis, 5th Edition,
2. Arthur I. Vogel, A Text Book of Practical Organic Chemistry, Longman Sc & Tech, 5-edition.

CO Statements:

1. CO1: To familiarize the solubility nature of organic substances of different functional group. To learn the pilot separation of binary mixtures. To familiarize the systematic producers organic substances analysis.
2. CO2: To know the preparation involving nitration, bromination, oxidation, reduction etc.
3. CO3: To familiarize the test involving identification of special elements.
4: CO4: To learn the confirmatory test for various functional groups. To learn the preparations of derivative all functional groups.
5. CO5: To know the different techniques for separation of the mixtures and natural products.

CH 5106	Synthetic Methods in Organic Chemistry	L	T	P	C
M Sc in Applied Chemistry, Second semester (Core)		4	0	0	4
Prerequisite(s): No Prerequisites					

Reagents in organic synthesis

Use of following reagents in organic synthesis and functional group transformations: Gilman's reagent (lithium dimethyl cuprate), lithium diisoproplamide (LDA), trimethylsilyl iodide or chloride, Woodward and Provost hydroxylation, Phase transfer catalyst, Crown ether and Merrifield resin, Peterons's synthesis, Wilkinson's catalyst, Baker's yeast, diazomethane, polyphosphoric acid, DCC dicyclo hexyl carbondioxide, yields, enamines. Wilkinson catalyst, Baker's yeast.

Synthetic methods in organic transformations:

Orbital symmetry and Pericyclic reactions, selection rules and stereochemistry of eletrocyclic reactions, cycloaddition and sigmatropic rearrangement. Cope rearrangement and Claisen rearrangement.

Photochemical reactions: Cis-trans isomerism, Patterno-Buchii reaction, photochemistry of arenes, Barton reaction.

Chiron approach in organic synthesis and related aspects of conformational analysis of carbohydrates. Selective organic transformations: chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity.

Oxidation and Reduction:

Oxidation with Cr and Mn compounds, oxidation of alcohols, aldehydes, C=C double bonds, C-H bonds in organic oxidation, SeO_2 oxidation of allylic C-H bonds.

Catalytic hydrogenation and dehydrogenation, dissolved metal reduction, metal hydride reductions of carbonyl compounds and other functional groups. Meerwin-Podorf Varley reduction. Hydroboration, Wolf-Kishner reduction.

Books/References:

1. Advanced Organic Chemistry: Reaction Mechanism and Structure by J. March, John Wiley.
2. Advanced Organic Chemistry, Part B, Carey and Sundberg, Fifth Edition, Springer.
3. Designing Organic synthesis – S. Warren, Wiley.
4. Some modern methods of organic synthesis, W. Carrathers, Cambridge Univ. Press

CO Statements:

1. CO1: Understand and interpret different synthetic pathways of synthetically useful reagents and catalysts in organic transformation reactions.
2. CO2: Thorough knowledge about the different aspects of pericyclic and heterocyclic reactions as well as some important rearrangement reactions
3. CO3: Explain the importance of various oxidation and reduction reactions using transition and main-group metal compounds in organic synthesis.

CH 5107	Environmental Chemistry and Engineering	L	T	P	C
M Sc in Applied Chemistry, Second semester (Core)		4	0	0	4
Prerequisite(s): No Prerequisites					

Fundamentals of Environmental Chemistry: Classification of elements, Sources, Classification and Properties of Air Pollutants, Indian National Ambient Air Quality Standards. Impact of air pollutants on human health, plants and materials. Principle and working of: settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator. Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion. Indoor air pollution, Vehicular emissions and Urban air quality. Air pollution risk assessment, emission and effluent analysis, Temperature Lapse Rates and Stability, Wind Velocity and Turbulence.

Composition of air. Particles, ions and radicals in the atmosphere. Chemical speciation. Chemical processes in the formation of inorganic and organic particulate matters, thermochemical and photochemical reactions in the atmosphere, Oxygen and Ozone chemistry. Photochemical smog.

Types and sources of water pollution. Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD,TOC, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN. Indian standards for drinking water (IS: 10500, 2012). Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Common effluent treatment plant.

Disinfection: different types, disinfectants, factors affecting disinfection, methods of disinfection, and chemistry of chlorination. Water Softening: Ions causing hardness, Langelier index, various methods. Fluoridation and de-fluoridation - Principles and design. Adsorption Process: Types, factors affecting adsorption, kinetics and equilibrium – different isotherm equations and their applications. Advanced water treatment: Ion exchange, solvent extraction, electro-dialysis, Reverse Osmosis, Ultra filtration.

Industrial wastewater treatment: Waste minimization, Equalization, Neutralization, Oil separation, Flotation, Precipitation, Heavy metal Removal, aerobic and anaerobic biological treatment, conventional activated sludge process and its modifications. Theoretical principles and design – attached growth system – trickling filter, chemical oxidation, ozonation, Photocatalysis, Wet Air Oxidation, Evaporation, Membrane Technologies, Nutrient removal.

Toxic chemicals: Pesticides and their classification and effects. Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O_3, PAN, VOC and POP. Carcinogens in the air.

Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components). Analysis of soil quality. Soil Pollution control. Industrial effluents and their interactions with soil components. Soil microorganisms and their functions – degradation of pesticides and synthetic fertilizers.

Environmental Biotechnology: Bioremediation – definition, types and role of plants and microbes for in situ and ex situ remediation. Bioindicators, Biofertilizers, Biofuels and Biosensors.

Solid Waste – types and sources. Solid waste characteristics, generation rates, solid waste components, proximate and ultimate analyses of solid wastes. Solid waste collection and transportation: container systems – hauled and stationary, layout of collection routes, transfer stations and transportation. Solid waste processing and recovery – Recycling, recovery of materials for recycling and direct manufacture of solid waste products. Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermicomposting, biomethanation of solid waste. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste.

Hazardous waste – Types, characteristics and health impacts. Hazardous waste management: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal. E-waste: classification, methods of handling and disposal. Plastic waste: sources, consequences and management.

Text Books/References:

1. Environmental Pollution Control Engineering, C. S. Rao, Wiley-Eastern Ltd., New Delhi
2. Environmental Chemistry, A. K. Dey, Wiley-Eastern Ltd., New Delhi
3. Air Pollution, John E. Seinfeld, McGraw-Hill, New York
4. Water Quality and its Control, John-Wiley & Sons, New York
5. Electrochemical Methods, A. J. Bard and L. R. Faulkner, John Wiley.
6. Environmental Pollution, H. M. Dix., Wiley.
7. Water Treatment - Principles and Design, J. M. Montgomery., Wiley.

CO Statements:

1. CO1: Familiarize with the fundamentals of Environmental chemistry and its various features.
2. CO2: Learn in details about the various processes used for the control of gaseous pollutants.
3. CO3: Knows the basics of water pollution and water quality parameters.
4. CO4: Knows a detailed study of the various methods used to control water pollution.
5. CO5: Understand the fundamentals of pesticides, heavy metals, metalloids and carcinogens in the air.
6. CO6: Learn in details about the numerous process used for industrial wastewater treatment.
7. CO7: Understand and explain the various properties, analyses, and pollution control of soil, and their interactions with various substances.
8. CO8: Learn the basics of environmental biotechnology.
9. CO9: Explain in details the sources, types, characteristics, and health impacts of solid and hazardous wastes and their treatment methods.
10. CO10: Learn about the causes of pollution and health risk in daily life treatments

CH 5108	**Physical Methods in Analytical Chemistry**	**L**	**T**	**P**	**C**
M Sc in Applied Chemistry, Second semester (Core)		4	0	0	4
Prerequisite(s): No Prerequisites					

Chromatography and Spectroscopy Techniques: Ultraviolet-Visible Spectroscopy, Atomic Absorption Spectroscopy (AAS), Infrared spectroscopy and laser Raman Spectroscopy, NMR and EPR Spectroscopy, Mass spectroscopy, GC-MS, ICAP, TGA-DTA. **Electroanalytical methods**: Coulometry, Voltammetry, Polarography, Electrogravimetry, Potentiometry. **Material Characterization Techniques:** X-ray fluorescence (XRF), Atomic force microscopy (AFM), X-ray diffraction (XRD), Scanning electron

microscopy (SEM), Transmission electron microscopy (TEM), X-Ray Photoelectron Spectroscopy (XPS), Fluorescence Spectroscopy.

Text Books/ References:

1. Spectroscopic Identification of Organic Compounds, R.H. Silverstein, G.C. Bassler and T.C. Morril, John-Wiley.
2. Physical Methods for Chemists, 2nd Ed., R.S. Drago.
3. Fundamental of Molecular Spectroscopy, 4th Ed., C.M. Banwell and E.M. McCash, Tata-McGraw Hill.
4. Analytical Chemistry, J.H. Kennedy.
5. Material Characterization Techniques, Sam Zhang, Lin Li, Ashok Kumar CRC press, 2008

CO Statements:

1. CO 1: Explain the aims of chromatography and spectroscopy techniques.

2. CO2: Explain the principle and instrumentation of Ultraviolet-Visible Spectroscopy, absorption spectrum, type of transitions, absorption laws, and applications.

3. CO3: Describe the principle of IR spectroscopy and identify the functional groups present in the molecules.Define Raman spectroscopy and its working. Students will be able to determine the modes of vibrations exist in the molecules.

4. CO4: Elucidate the Nuclear Magnetic Resonance (NMR) and Electron Paramagnetic Resonance spectroscopy and able to detect the purity of a sample as well as its molecular structure.

5. CO5: Understand the principle mass spectroscopy and able to quantify the known materials, identify unknown compounds within a sample.

6. CO6: Learn the principle of TGA/DTA and can analyze the physical and chemical properties of materials as a function of increasing temperature.

7. CO7: Learn the concept of electroanalytical methods including coulometry, voltammetry, polarography, electrogravimetry, potentiometry etc. and will be able to study chemical substances that is of interest by measuring the voltage (potential) and /or current signals in an electrochemical cell

CH 5109	**Physical Chemistry Laboratory**	**L**	**T**	**P**	**C**
M Sc in Applied Chemistry, Second semester (Core)		0	0	6	4
Prerequisite(s): No Prerequisites					

List of experiments:

1. To determine the composition of a mixture of acetic acid and hydrochloric acid by Conductometric titration.
2. Determination of concentration of sulphuric acid, acetic acid and copper sulphate by Conductometric titration with NaOH.
3. Verification of Beer-Lambert's law with a green solution.
4. Determination of concentration of Fe (III) present in solution by UV-Vis spectrophotometer.
5. To determine the amount of Mn present in a sample of MnSO4 using UV-Visible spectroscopy.

6. Investigation of absorption of oxalic acid from aqueous solution by activated charcoal and examines the validity of Langmuir adsorption isotherm.
7. To obtain Fraundlich adsorption isotherm for adsorption of oxalic acid on activated charcoal.
8. To determine the viscosity coefficient of a given solution (or Liquid) by Ostwald Viscometer.
9. To determine the surface tension of a supplied liquid or a solution by drop-weight (or drop-counting) method using Stalagmometer.
10. To determine the equilibrium constant for the reaction KI + I2 ⟷ KI3.
11. To determine from solubility measurements the true thermodynamic solubility of product of calcium sulphate at room temperature.
12. Determination of partial molar volumes of methanol in dilute aqueous solutions.

Text Books/ References:

1. V. D. Athawala & P. Mathur. Experimental Physical Chemistry, New Age International (2001)
2. D. P. Shoemaker, C. W. Garland, & J. W. Nibler. Experiments in Physical Chemistry, McGraw Hill Education; 8th Edn., (2008).
3. B. Viswanathan & P.S. Raghavan. Practical Physical Chemistry, Viva Books private Ltd. (2014).

CO Statements:

1. CO1: Design and perform experiments.
2. CO2: Learn about various instrumental techniques used for analyses of sample and their estimation
3. CO3: Critically examine and interpret the experimental data.

CH 6101	Chemical Engineering Principles	L	T	P	C
	M Sc in Applied Chemistry, Third Semester (Core)	4	0	0	4
Prerequisites (s): No Prerequisites					

Units – dimensions – conversion of units – introduction to unit operations and process – material and energy balances with and without chemical reactions – recycling and bypassing and purging concepts in unit process and unit operations – laws of thermodynamics.

Steady state – conservation of energy and mass-entropy production and entropy flow in open system – fluxes and forces – transformation of properties of rates and affinity – microscopic reversibility and Onsager reciprocal relation, thermokinetic effect – irreversible thermodynamics for non - linear regime.

Fluid statics – Bernoulli theorem – applications, Newtonian and non-Newtonian fluids – flow of fluids through pipes, fluidized bed and packed beds, flow meters and pumps, mixing, screening, settling and filtration.

Conduction, convection, radiation–Fourier's law – problems, overall heat transfer coefficients, natural and forced convection.

Diffusion – Fick's law of diffusion – mass transfer coefficients and theories, distillation, adsorption, leaching and extraction.

Analyzing batch reactor kinetic data – integral and differential methods, constant and varying volume systems, concept of ideal reactor and their performance equations, design of ideal reactors for single and multiple reactions, choosing right kind of reactor, non-ideal reactors – RTD concepts.

Text Books/References:

1. Christi J. Genekoplis "Transport Process and Unit operations", 4th Edn., Prentice Hall of India Pvt Ltd. Mccabe W.L, Smith J and Harriot P, "Unit Operations of Chemical Engineering", 6th Edn., Tata McGraw Hill, 2001.
2. Smith J M, Van Ness H C, "Introduction to Chemical Engineering Thermodynamics", McHraw Hill, 4th Edn., 1987.
3. Narayanan K V, "A text book of Chemical Engineering Thermodynamics", Prentice Hall Pvt Ltd. Levenspiel, "Chemical Reaction Engineering", Jhon Wiley Publishers, 3rd Edn., 2003.
4. S.Akhanzara and V.Kafaror, 'Experiment optimization in chemistry and chemical engineering, Mir publishers, Mascow, (1982).

CO Statements:

1. CO1: Understand the fundamentals of various unit operation and processes used in chemical engineering
2. CO2: Explain the various modes of heat transfer and ability to solve various problems related to heat transfer in chemical engineering
3. CO3: Explain the various modes of mass transfer and ability to solve problems related to mass transfer.
4. CO4: Demonstrate and conceptualize the basics of fluid statics.
5. CO5: Learn about the fundamentals of batch reactor and choosing right kind of reactor for particular chemical reactions.

CH 6102	**Polymer chemistry**	**L**	**T**	**P**	**C**
	M Sc in Applied Chemistry, Third Semester (Core)	4	0	0	4
Prerequisites (s): No Prerequisites					

Introduction: Classification, raw materials for polymers. Natural polymers like rubber, natural fibers, silk fibers, Synthetic polymers like HDPE, LDPE, PP, PS, Nylon; synthetic polymeric resins and rubbers, moulding,gas cracker, naphtha cracker.

Kinetics and mechanism of polymerization: Degree of polymerization and molecular weight of polymer, kinetics of various types of polymerization, co-polymerization, reactivity ratio, molecular weight distribution, control of molecular weight. Stereochemistry of polymers,

Processing Techniques: various polymerization techniques like rotational casting, film casting, injection moulding, blow moulding etc.

Polymer characterization: Determination of molecular weight and molecular weight distribution, GPC, light scattering, end group analysis method, Zimm plot, viscosity of polymer solutions, thermal, mechanical, rheological and electrical properties of polymers,Characterization of polymer by IR, NMR and Raman Spectroscopy. Therman properties by TGA and DSC.

Conducting Polymer: Synthesis, Properties and Applications of polyacetylene (PA), Polyaniline (PANI), polypyrrole(PPY), poly(phenylene)s (PPs), Poly(p-phenylene) (PPP), poly(p-phenylenevinylene) (PPV), poly(3,4-ethylene dioxythiophene) (PEDOT), polyfuran (PF).conducting polymer and solar cell.
Polymer environmental issues: Plymer disposal, incineration, land filling, recycling. Biodegradable polymers.

Text Book/References:
1. Misra, G.S. Introductory Polymer Chemistry (Wiley Eastern Limited,)
2. Billemeyer, F. Textbook of Polymer Science (Wiley,).
3. Odian, G. Principles of Polymerization (Wiley, 2004)
4. Sun, S. F. Physical Chemistry of Macromolecules, 2nd edn. (Wiley, 2004)
5. International Advanced Research Journal in Science, Engineering and Technology Vol. 2, Issue 11, November 2015.

CO Statements:
1. CO1: The course provides an introduction to polymer chemistry based classifications and synthesis.
2. CO2: The course provides kinetics, stereochemistry and reaction mechanism of polymers.
3. CO3: Basic knowledge is provided with regards to polymerization processing techniques.
4. CO4: To know the different techniques for characterization of polymers and stability of polymers.
5. CO5: Basic knowledge is provided with regards to conducting polymers and their synthesis and applications.

CH 6103	Green Chemistry and Technology	L	T	P	C
	M Sc in Applied Chemistry, Third Semester (Core)	4	0	0	4
Prerequisites (s): No Prerequisites					

Green Technologies and Green Chemistry:
Challenges and opportunities; Werner's twelve principles of green chemistry with special emphasis on concept of atom economy, avoidance of protecting groups, use of catalysts, use of green solvents, solventless reactions, biodegradability of products, importance of analytical techniques
Green Reagents and Green Catalysts:
Green reagents – Dimethylcarbonate (DMC), polymer supported reagents viz., polymer supported peracids, poly-N-Bromosuccinimide (PNBS), polystyrene witting reagents; Green catalysts – Acid catalysts viz.,

microencapsulated Lewis acids, Basic catalysts viz., metals/ metal oxides/ metal hydroxides, polymer supported catalysts viz., polystyrene $AlCl_3$

Phase Transfer Catalysis in Green Synthesis:

Advantages of PTCs, application of PTCs in synthesis of nitriles from alkyl or acyl halides, generation of dihalocarbenes, elimination reactions

Microwave Induced Green Synthesis:

Principles and mechanism of MW assisted Green synthesis; application of MW in Hoffmann elimination reactions, oxidation of toluene, deacetylation, deprotection

Ultrasound Assisted Green synthesis:

Principles and mechanism of ultrasound assisted organic reactions; application in ultrasound in esterification, safonification and substitution reactions

Ionic Liquids as Green solvents:

Concepts of ionic liquids as solvents, acidic and neutral ionic liquids mediated organic reactions

Solvent-free organic transformations as Green Reactions:

Halogenation, Micheal addition, Aldol condensation, Witting reactions

Text Books/ References:

1. Handbook of Green Chemistry and Technology, J H Clarke and D J Macquairrie (Ed) 2002, Wiley-Blackwell
2. Green Reaction Media in Organic Syntheses, M. Koichi, (Ed) 205, Wiley-Blackwell
3. Methods and Reagents for Green Chemistry: An introduction; Wiley Inter-science (Ed) 2007.
4. New Trends in Green Chemistry, 2nd Ed, V K Alhuwalia and M Kidwai

CO Statements:

1. CO1: Understand the fundamental concepts of Green science and Green technologies especially with reference to Werner's principles
2. CO2: Interpret the relevance and significance of Green reagents and Green catalysts in practicing Green science in academia and industry
3. CO3: Explain the importance of phase transfer catalysis for enhancing the impact of green chemistry
4. CO4: Understand the significance of Microwave assisted synthesis for making organic reactions cleaner and energy efficient
5. CO5: Explain the concept of ultrasound assisted reactions and their benefit in the context of Green science
6. CO6: Understand the concept of ultrasound assisted reactions and their role in making the reactions greener
7. CO7: Conceptualize the idea of solvent-free reactions and their positive impact environmentally benign reactions

CH 6104	Environmental Chemistry Laboratory	L	T	P	C
	M Sc in Applied Chemistry, Third Semester (Core)	0	0	6	4
Prerequisites (s): No Prerequisites					

List of experiments:

1. Determine the total hardness of water and also find out the temporary and permanent hardness of the given sample.
2. Determine the alkalinity and acidity of water.
3. Determine the amount of chloride present and beark point chlorination of the given sample.
4. To determine the biochemical oxygen demand (BOD) of the sample.
5. To determine the chemical oxygen demand (COD) of the sample.
6. To determine the total dissolved solid (TDS) of the sample.
7. Determine the concentration of benzoic acid and sorbic acid present in soft drinks.
8. Determine the concentration of SO_2 present in soft drinks.
9. To determine the amount of calcium present in egg shells.
10. To determine the available sulphur in the soil.
11. To determine the amount of Fe(III) present in the water.
12. To determine the amount of Arsenic (As) present in the water.
13. To determine the amount of Mercury (Hg) present in the water.
14. To determine the amount of Lead (Pb) present in the water.
15. Separation and identification of pesticide residues in soil.
16. Development of adsorbents for the removal of organic matter from drinking and industrial wastewater.
17. Development of adsorbents for the removal of As, Fe and Hg from water bodies.
18. Development of coagulants for the removal of organic matter from drinking and industrial wastewater.
19. Development of coagulants for the removal of As, Fe and Hg from water bodies.
20. Removal of pollutants/impurities from wastewater by advanced oxidation process.

Text books/ References:

1. P.D. Vowles & D.W. Connell. Experiments in Environmental Chemistry: A Laboratory Manual, Pergamon (1980).

2. D. Frank. Environmental Laboratory Exercises for Instrumental Analysis and Environmental Chemistry, John Wiley and Sons Ltd. (2004).

3. R. Gopalan, A. Anand & R.W. Sugumar. A Laboratory Manual for Environmental Chemistry, I.K. International Publishing House Pvt. Ltd. (2012).

CO Statements:

1. CO1: Development of experimental skills for analysis of various wastewater parameters.
2. CO2: Learn about the analysis of wastewater, soils and soft drinks.
3. CO3: Carry out independent analyses with the developed skills.

CH 6106	**Synthesis and Reaction of Inorganic and Organometallic Compounds**	**L**	**T**	**P**	**C**
M Sc in Applied Chemistry, Fourth Semester (Core)		4	0	0	4

Prerequisite(s): No Prerequisites

Synthesis and Structure of Compounds of Main Group Elements

Synthesis and structures of compounds of alkali metals and those of calcium, magnesium, barium and strontium. Silicates, zeolites, hydrazines, diazenes, hydrazoic acids, hydroxylamines, oxides of nitrogen, oxides and oxoacids of phosphorus and their derivatives, condensed phosphates, oxides and oxoacids of sulfur, halogen oxides and oxoacids, noble gas compounds.

Reaction and their Mechanism of Transition Metal Complexes

Substitution in octahedral and square planar complexes; lability, trans-effect, conjugate-base mechanism, Electron transfer reactions; outer sphere and inner sphere mechanism, Inorganic photochemistry; photosubstitution and photoredox reactions of chromium, cobalt and ruthenium compounds.

Organometallic Chemistry of Transition Metals

18-electron rule, metal carbonyls, metal nitrosyls, isolobal analogy, metal carbenes; Schrock's carbenes and Fischer's carbenes, metal arene and metallocene complexes, oxidative addition, reductive elimination, insertion reaction, metal-metal bonding and metal clusters, organometallic catalysts in industrially important reactions.

Text books/ References

1. Concepts and Models of Inorganic Chemistry by B. E. Douglas, D. H. McDaniel, J. J. Alexander, John Wiley, 1993, 3rd Ed.
2. Inorganic Chemistry of Main Group Elements by R Bruce King, VCH 1995
3. Reaction Mechanism in Inorganic Chemistry by R. R. Jordan Oxford Univ. Press, 1998. 2nd Ed.
4. Advanced Inorganic Chemistry by F. A. Cotton and G. W. Wilkinson, John Wiley & Sons, 1988, 5th Ed.
5. Organometallics by Ch. Elschenbroich, A. Salzer, VCH, 1995, 2nd Ed.
5. Organometallic Chemistry of the Transition Metals by R. H. Crabtree, John Wiley, 1993, 2nd Ed.
7. Inorganic Chemistry by D. F. Shriver and P. W. Atkins, 3rd Ed.

CO Statements

1. CO1: Understand different aspects of synthetic, structural and applications of alkali and alkaline earth metals, some selected compounds of nitrogen, phosphorus, sulfur, halogen and noble gas metals
2. CO2: Interpret the reactivity of transition metal complexes in various common geometries, various mechanistic aspects of such reactions and photochemical reactivity of some selected transition metal complexes
3. CO3: Explain the synthesis, bonding and structure of organometallic compounds of transition metals specifically metal carbonyls, metal nitrosyls and metallocenes and metal carbenes including those that are applied as heterogeneous catalysts in industrially important chemical reactions.

CH 6131	Petroleum Science and Technology	L	T	P	C
	M Sc in Applied Chemistry, Fourth Semester (Elective)	3	0	0	3
Prerequisites (s): No Prerequisites					

Petroleum a Natural Resource: Origin (Theories of Organic and Inorganic Origin), Formation and Composition; Major petroleum fractions and products (refinery gases gasoline, naphtha, kerosene, diesel, fuel oil, lubricating oil); Hydrocarbons and non-hydrocarbons present (type, name, structure, role); Crude assay, evaluation of crude and petroleum fractions; Specification of petroleum products.

Petroleum Processing Overview: Petroleum processing data; Fractionation of petroleum; Treatment techniques; Thermal and catalytic processes practice in Petroleum refinery, Hydrotreating and Hydrocracking: Fundamentals; Recent advances in Hydrocracking; Current progresses in catalyst and catalysis of Hydrotreating; Asphalt Technology; Catalytic Processes for light Olefin production.

Modern Processing Techniques: Kinetics and Mechanisms of Fluid catalytic cracking; Ultra deep Desulphurization of Diesel: How an understanding of the underlying kinetics can reduce Investment costs; Ultra-clean diesel fuels by Deep Desulphurization and Deep Dearomatization of middle distillates; Integrated methodology for characterization of Petroleum Samples and its application for Refinery product quality modeling.

Analytical and Separation Techniques: Quantitative and Qualitative Steps in Analysis of Petroleum; Analytical Methods in Geochemistry for Reservoir Rocks and Fluids; Distillation and Classification of Petroleum; First, Second and Third Generation Petrochemicals; Miscellaneous Petrochemicals.

Petrochemical Industry and Environment: Environmental pollution control in Petroleum refinery. Climate change and the petrochemical industry; Methodology and Assumptions for Estimating Particulate and Exhaust Emission; Euro and Bharat Stage emission limit; Petroleum rules, Gas cylinders rules-Explosives Act 1983.

Text Books/References:

1. The Chemistry and Technology of Petroleum, James G Speight.
2. Advanced Petroleum Refining, G Sarkar, Khanna Publishers.
3. Modern Petroleum Refining Processes, B K Bhaskara Rao, Oxford and IBH Publishing Company Pvt Limited.
4. Chemicals from Petroleum by A. L. Waddams

5. Practical Advances in Petroleum Processing; Vol 1, Edited by C. S. Hsu and Paul R. Robinson, Springer.
6. Fundamentals of Petroleum Refining; Elsevier Limited.
7. Fundamentals of Industrial Catalytic processes, R. J. Farrauto, CH Bartholomew Blackie Academic & Professional, London 1997.

CO Statements:

1. CO1: Learn about the fundamentals of crude and petroleum oils and their various fractions.
2. CO2: Understand the various processes used in Petroleum Refining and role of catalysis in Petroleum Refining and for light Olefin production.
3. CO3: Explain and conceptualize the various operations in Modern refinery.
4. CO4: Understand the various Analytical and Separation Techniques used in petroleum refinery.
5. CO5: Know about the various environmental aspects and pollution control in petroleum industry

CH 6132	Catalysts and Surface Science	L	T	P	C
	M Sc in Applied Chemistry, Fourth Semester (Elective)	3	0	0	3
Prerequisites (s): No Prerequisites					

Introduction: Definition, role of catalysts, classification of catalysts. Homogeneous catalysts: Mechanism of homogeneous catalysis, acid-base catalysis, enzyme catalysis, micellar catalysis, phase transfer catalysts, homogeneous catalysis in industry, Zigler-Natta catalysts, catalysis for the synthesis of Bioactive compounds like fluoxetine, (+)-biotin etc. carbonylation reactions, hydroformylation, metallocene catalysts.

Characterization of catalysts and their surfaces: Kinetics of surface reactions, chemisorptions, role of chemisorptions in catalysis, Turnover frequency (TOF), Structure- reactivity relationship, Methods of surface analysis, surface area, pore size, void fraction, particle size, mechanical strength, surface chemical composition, surface acidity and reactivity.

Theory and mechanism of heterogeneous catalysts: Adsorption and catalysis, mechanism of heterogeneous catalysis, kinetics of heterogeneous catalytic reactions, Langmuir-Hinshelwood and Eley-Riedl mechanism, volcano principle, shape and size selectivity of catalysts.

Organocatalysis: Introduction and chiral catalysis in the synthesis of enantiomerically pure compounds. chiral Schiff-base complexes and rheir applications in organic transformations.

Nanocatalysis :Introduction to Nanocatalysis, advantages of nanocatalysts over conventional homogeneous and heterogeneous catalysts, strategies for fabrication of colloidal and supported metal nanocatalysts and their application in some chosen organic reactions, magnetically recoverable nanoparticles for green and sustainable catalysis, carbonaceous magnetic nanocatalysts, palladium nanoparticles catalyzed Heck

reaction, amine functionalized MCM-41 mesoporous catalysts for Henry reaction, Knoevenagel condensation reaction catalyzed by amino-functionalized mesoporous silica.

Books/ References:

1. Bartholomew, C. H., Furrauto, R. J. Fundamentals of Industrial Catalytic Processes 2nd edn., (Wiley Interscience, 2006).
2. Catalytic Chemistry, B.C. gates, John Wiley & sons Inc.
3. Chakrabarty, D. K., Viswanathan, B. Heterogeneous Catalysis (New Age Int., 2008).
4. Nanocatalysis: Synthesis and Applications, First Edition. (Eds) VPolshettiwar and T Asefa, 2013 John Wiley & Sons
5. 2. Metal Nanoparticles for Catalysis: Advances and Applications, RSC Catalysis Series No. 17, Edited by Franklin Tao, The Royal Society of Chemistry 2014
6. 3. Magnetically Recoverable Nanocatalysts, Chemical Reviews, 2011, 111, 3036–3075

CO Statements:

1. CO1: Knowledge of Principles and practice of homogeneous and heterogeneous catalysis in chemistry. Reactions and their applications in industry and synthesis of bioactive molecules.
2. CO2: Characterization of catalysts and their surfaces and evaluate structure-reactivity relationship.
3. CO3: Understanding of the mechanism and kinetics of heterogeneous catalytic reactions.
4. CO4: Choice of organ-catalyt and their applications in the synthesis of bioactive molecules.
5. CO5: Understand concept of Nanocatalysis, their advantages over conventional homogeneous and heterogeneous catalysis. Explain the mechanism of various industrially important catalytic reactions and interpret the relevance of relevance such catalytic processes to green and sustainable chemistry.

CH 6133	Fuel Technologies	L	T	P	C
	M Sc in Applied Chemistry, Fourth Semester (Elective)	3	0	0	3
Prerequisites (s): No Prerequisites					

Principle of combustion. Solid, liquid and gaseous fuels. Coal as a source of energy and chemicals in India. Coal preparation. Carbonization, gasification and liquefaction of coal and lignite. Petroleum and its derived products. Petroleum refining. Properties and testing of petroleum and petroleum products. Inter-conversion of fuels. Natural gases and its derivatives, sources and potential. Cleaning and Purification of gaseous fuels. Combustion appliance for solid, liquid and gaseous fuels. Introduction to nuclear fuel.

Text Books/ References:

1. The Chemistry and Technology of Petroleum, James, G. Speight.
2. Fuel and Combustion, Samir Sarkar, Orient Longman.

3. Petroleum Refining Process, James, G. Speight.
4. Chemistry of Coal Utilization, Eliot M.A. (Ed.), Wiley.
5. Advanced Petroleum Refinery, G.N. Sarkar, Khanna Publishers.
6. Chemistry of Coal Utilization, Tschemler, H and De Riuter, J.Wiley.

CO Statements:

1. CO1: Learn about the fundamentals of solid, liquid and gaseous fuels.
2. CO2: Know the detailed study of coal processing.
3. CO3: Demonstrate and know the detailed study of petroleum processing.
4. CO4: Understand the basics of Inter-conversion of solid, liquid and gaseous fuels.
5. CO5: Explain the fundamentals of cleaning and purification of gaseous fuels.
6. CO6: Know the various combustion appliances used for solid, liquid and gaseous fuels.
7. CO7: Learn about the basics of nuclear fuels.

CH 6134	Energy and Environment	L	T	P	C
	M Sc in Applied Chemistry, Fourth Semester (Elective)	3	0	0	3
Prerequisites (s): No Prerequisites					

Fundamental of Energy: Energy; work and power; different form of energy; first and second law of thermodynamics, standard cycles, heat transfer, concept of entropy and photosynthesis.

Relationship among Energy, Environment and Economical Level of Development: Resources of energy and energy use pattern in different parts of the world; Indian energy scenario for domestic, agriculture, transport and industrial sector and its impact on the environment.

Conventional Energy Sources and Technology: Coal; petroleum; natural gas; lignite; cracking of petroleum; furnace; boiler; turbines; fluidized bed systems and combined cycle systems; resources and reserves for oil, coal, natural gas; nuclear energy- fission energy, fusion energy, principles of MHD generator, MHD equation and power from MHD systems.

Renewable Energy Sources: Solar energy; Flat plate collectors, theory of Flat plate collectors, Photovoltaics & Solar Ponds. wind energy; tidal energy; geo-thermal; mini and micro hydropower development; ocean energy(OTEC); biomass gasification for thermal, electrical and mechanical power generation; biomass gasifier systems; gasifier coupled dual fuel engine systems; characteristics of producer gas; efficient & pollution free biomass stoves; bio-conservation technology; energy recovery from wastes; and environmental impacts of large scale exploitation of renewable energy.

Energy Conservation and Energy Economics: Energy efficiency at national level; Improving energy efficiency; Energy analysis; Concept of exergy (theoretical treatment); Capital recovery factor; Levelised annual cost; Economic analysis of wind electric generation and thermal power systems.

Text Books/References:

1. John W. Twidell and Anthony D. Weir, E. & F. N. Spon Ltd., London, 1986.
2. Edward H. Thorndike, Energy & Environment: A Primer for Scientists and Engineers, Addition-Wesley Publishing Company, Reading, 1976.
3. Thomas B. Johanson et. al., Renewable Energy: Sources for Fuels and Electricity, Earth Scan Publications Ltd., London.
4. David Merrick and Richard Marshall, Energy-Present and Future options, John Wiley & Sons, New York, 1981.
5. P. Chartier et. al., Biomass for Energy & Environment, proceedings of the European Biomass Conference, Pergamon Press, 1996.

CO Statements:

1. CO1: Understand the fundamental concepts of Energy Science.
2. CO2: Demonstrate the relationship among Energy, Environment and Economical Level of Development.
3. CO3: Know the detailed study of Conventional Energy Sources and Technology.
4. CO4: Explain in details the various sources of renewable energy and environmental impacts of large scale exploitation of renewable energy
5. CO5: Learn about the energy conservation and energy economics.

CH 6135	Natural Products and Medicinal Chemistry	L	T	P	C
	M Sc in Applied Chemistry, Fourth Semester (Elective)	3	0	0	3
Prerequisites (s): No Prerequisites					

Concept of drug, lead compound, lead modification, prodrugs and soft drugs: structure - activity relationship (SAR), quantitative structure – activity relationship (QSAR), factors affecting bio-activity resonance, inductive effect, isomerism, bio- isomerism, spatial consideration: theories of drugs, activity-occupancy theory, rate theory, induced fit theory

Concept of drug receptors, elementary treatment of drug receptor interaction; physiochemical parameters-lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials; factors affecting mode of drug administration, absorbtion, metabolism and elimination; significance of drug metabolism in medicinal chemistry

Cell wall biosynthesis, inhibitors of β- lactum rings, antibiotic inhibiting protein synthesis, Isolation, structural elucidation, synthesis, SAR and mode of action of penicillin; mode of action of following antibiotics; streptomycin, tetracycline and chloramphenicol

General classification of natural products; Methods of extraction, isolation and characterization of natural products, various separation techniques used for isolation of natural products. Biosynthesis pathways, primary metabolites, their examples. Secondary metabolites, various classes of secondary metabolites (e.g. Alkaloids, glycosides, tannins, lignans, saponins, lipids, flavonoids, coumarins, anthrocyanidines, etc.)

Biosynthesis of diterpenes, higher terpenes and steroids; Nomenclature of steroids and synthesis of squalene; Lanosterol and caretonoids; Synthesis of equlenins; Estrogene and total synthesis of non-aromatic steroids (progesterones): Miscellaneous transformation of steroid molecules.

Text Books/ References:

1. Burger: Medicinal Chemistry and Drug discovery Vol 1 Ed. M. E. Wolf, John Wiley (1994)
2. Goodman and Gilman; Pharmacological Basis of Therapeutics, McGraw Hill (2005)
3. S. S. Pandeya and J. R. Dimmock, Introduction to drug design, New Age International (2000)
4. Graham and Patrick, An Introduction to Medicinal Chemistry, 4th Ed., Oxford University Press (2009)
5. K. Nakanashi, Natural Products Chemistry, Vol- I and Vol- II, Academic Press. New York and London.

CO Statements:

1. CO1: Assistance in lead compound identification and optimization and Structure-activity relationship (SAR) analysis
2. CO2: Discussion, analysis and Improvement of chemical properties associated with drug receptors.
3. CO3: Understanding of the biosynthesis of broad spectrum antibiotics and their SAR with mechanism.